

What we claim is:

1. In a method for estimating the multi-path delays in a signal received at an antenna array of  $k$  antenna elements, comprising estimating an impulse response at each  $k$  antenna, generating a space-time impulse response, forming a covariance matrix and resolving the covariance matrix with a known antenna array manifold, the improvement comprising the step of resolving the covariance matrix with a fictitious antenna array manifold.

2. A method for estimating the multi-path delays  $\tau_i$  in a signal using a spatially blind antenna array comprising  $k$  arbitrary antenna elements, comprising the steps of:

generating an impulse response  $h_k$  for each antenna element  $k$  in the antenna array;

determining a vectorized space-time impulse response  $I$  over the antenna array;

creating a covariance matrix  $C$ ;

creating a fictitious array manifold  $A_f$ , wherein  $A_f$  is spatially blind and independent of the array characteristics; and

resolving the covariance matrix  $C$  with the fictitious manifold  $A_f$  to thereby estimate the multi-path delays  $\tau_i$  independent of the array characteristics.

3. The method of Claim 2 wherein the impulse response estimate  $h_k$  is determined from the equation:

$$h_k = (ZZ^H)^{-1} Zr_k$$

where  $Z$  is a delay matrix and  $r_k$  is the column vector of the received signal at antenna element  $k$  of the antenna array, where  $k=1,2,\dots,m$ .

4. The method of Claim 3 wherein the space-time impulse response vector  $I$  is formed by stacking the individual impulse response estimates  $h_k$  into a column vector.

5. The method of Claim 2 wherein the fictitious manifold  $A_f$  is the aggregate of all vectors:

$$a = \begin{bmatrix} a_1 \\ a_2 \\ \vdots \\ a_m \end{bmatrix}, \text{ where } a_k (k=1,2,\dots,m) \text{ range over the set of complex numbers, where } m \text{ is the}$$

number of antenna elements in the array.

6. The method of Claim 2 wherein the covariance matrix  $C$  is generated according to the following equation:

$$C = \sum I I^H.$$

7. The method of Claim 2, wherein the fictitious array manifold  $A_f$  is used to form the space-time manifold and the space-time manifold operates to resolve the multi-path delays

8. The method of Claim 2 wherein the step of resolving the covariance matrix  $C$  to determine multi-path delays  $\tau_i$  uses the method of Multiple Signal Classification (MUSIC) techniques.

9. The method of Claim 2 wherein the step of resolving the covariance matrix  $C$  to determine multi-path delays  $\tau_i$  uses the Method of Alternating Projection (APM).

10. A method of estimating the multi-path delays  $\tau_i$  of a sequence of  $j$  blocks of a signal received at an antenna array of  $k$  isotropic antenna elements, independently of the spatial array characteristics of the antenna array, comprising the steps of:

deriving channel impulse response estimates  $h_{j,k}$  for each block  $j$  at each antenna  $k$ ;

determining a vectorized aggregate space-time impulse response  $I$  for each block  $j$ ;

forming an estimated covariance matrix for the sequence of  $j$  blocks;

providing an array manifold  $A_f$  void of spatial information; and,

resolving the covariance matrix with the array manifold  $A_f$  to determine the multi-path delays  $\tau_i$ .

11. The method of 10, wherein the impulse response estimate  $h_{j,k}$  for block  $j$  is determined from the equation:

$$h_{j,k} = (Z_j Z_j^H)^{-1} Z_j r_{j,k}$$

where  $Z_j$  is a delay matrix for block  $j$  and  $r_{j,k}$  is the column vector of the received signal for block  $j$  at antenna  $k$  of the antenna array, where  $k=1,2,\dots,m$ .

12. The method of 11, wherein the space-time impulse response vector  $I$  is formed by stacking the individual impulse response estimates  $h_{jk}$  into a column vector.

13. The method of 10, wherein the fictitious manifold  $A_f$  is the aggregate of all vectors:

$$a = \begin{bmatrix} a_1 \\ a_2 \\ \vdots \\ a_m \end{bmatrix}, \text{ where } a_k (k=1,2,\dots,m) \text{ range over the set of complex numbers, where } m \text{ is the}$$

number of an antenna element in the array.

14. The method of claim 10, wherein the covariance matrix  $C$  is generated according to the following equation:

$$C = \sum_{j=1}^J I_j I_j^H.$$

15. The method of Claim 10, wherein the fictitious array manifold  $A_f$  is used to form the space-time manifold and the space-time manifold operates to resolve the multi-path delays

16. The method of claim 10, wherein the step of resolving the covariance matrix  $C$  to determine multi-path delays  $\tau_i$  uses multiple signal classification techniques.

17. The method of claim 10, wherein the step of resolving the covariance matrix  $C$  to determine multi-path delays  $\tau_i$  uses Alternating Projection.

18. A system for estimating the multi-path delays  $\tau_i$  in a signal using a spatially blind antenna array comprising:

an antenna array for receiving the signal;

a means for generating an impulse response  $h_k$  for each antenna  $k$  in the antenna array;

a means determining a vectorized space-time impulse response  $I$  over the antenna array;

a means for creating a covariance matrix  $C$

a means for creating a fictitious manifold  $A_f$ , wherein  $A_f$  is spatially blind and independent of the array characteristics; and,

a means for resolving the covariance matrix  $C$  with the fictitious manifold  $A_f$  to estimate the multi-path delays  $\tau_i$  independent of the array characteristics.

19. The system of Claim 18, wherein the fictitious array manifold  $A_f$  in part forms the space-time manifold and a space-time manifold operates to resolve the multi-path delays